

‘Mais la fantaisie est-elle un privilège des seuls poètes?’ Schlick on a ‘Sinnkriterium’ for Thought Experiments

DANIEL DOHRN

Humboldt University, Berlin, Germany

Ever since the term ‘thought experiment’ was coined by Ørsted, philosophers have struggled with the question of how thought experiments manage to provide knowledge. Ernst Mach’s seminal contribution has eclipsed other approaches in the Austrian tradition. I discuss one of these neglected approaches. Faced with the challenge of how to reconcile his empiricist position with his use of thought experiments, Moritz Schlick proposed the following ‘Sinnkriterium’: a thought experiment is meaningful if it allows to answer a question under discussion by imagining the experiences that would confirm that the thought experimental scenario is actual. I trace this view throughout three exemplary thought experiments of Schlick’s.

Keywords: Thought experiment, Schlick, imagination, counterfactual, empiricism, verificationism.

Thought experiments are many and varied in science and philosophy. However, it is not so well understood how they contribute to our knowledge of the world. Unlike real experiments, they do not seem to interact with the world in a way that would allow us to gather new information. This concern is aggravated if one subscribes to a broadly empiricist view. According to such a view, any knowledge is eventually due to our more or less direct experiential contact with reality. Hence it is especially interesting to see how philosophers with a strong empiricist creed react to the practice of thought experimenting. In this article, I shall discuss one classical position within the movement of logical positivism which has hitherto been eclipsed by the contributions of contemporaries like Ernst Mach: Moritz Schlick’s proposal of how to make sense of thought experiments.

1. What is a Thought Experiment?

I shall start with a first take on thought experiments. The notion was coined in German by the physicist Hans-Christian Ørsted (1822), who used the word 'Gedankenexperiment' to refer to Kant's account of geometry in terms of the a priori use of imagination. Philosophers like Ernst Mach (1897) greatly expanded the scope of the term, including the scientific standard cases which also stand out in current debate, Galilei's falling bodies experiment, Newton's bucket experiment, and so on. Mach also gave a first empiricist account of how thought experiments can provide new knowledge. It makes tacit constraints imposed on imagination in the course of human evolution explicit. The role of retrieving and rearranging tacit knowledge plays a role in many recent accounts of thought experiments (e.g. Miscevic 1992).

Thought experiments do not only pervade science, they also abound in philosophy. I shall attempt at outlining some structural features of a typical philosophical thought experiment.

- 1) There is a question under discussion QUD.
- 2) An (as if) individual situation is described.
- 3) The situation is invented: we do not care whether it is actual.
- 4) Intuition: what would be the case in the situation?
- 5) The intuition is instrumental in answering the QUD.

Of course, this structure is only minimal. The aim is not to give necessary and sufficient conditions of thought experiments, but only to provide a first idea. I shall illustrate the structure by an example from the philosophical debate, so-called Gettier cases. I choose this example because it is one of the few successful thought experiments in philosophy, and it is used in many metaphilosophical debates (e.g. Williamson 2007).

1. QUD: Is knowledge justified true belief (JTB)?
- 2.–3. Invented scenario:

GC: At 8:28, Smith looks at a clock to see what time it is. The clock is broken; it stopped exactly twenty-four hours previously. Smith believes, on the basis of the clock's reading, that it is 8:28.(cf. Williamson 2009)

4. Intuition: GC is possible.

If GC were actual, would Smith have JTB?—Yes!

If GC were actual, would Smith have knowledge?—No!



5. Hence knowledge is not (just) JTB.

This is only a schematic presentation of main structural features. If we look for a sound logical argument, the following formalization is plausible (Williamson 2007: 195):

- (i) Necessarily, for any subject S and proposition p, S knows p if and only if S has justified true belief in p.

- (ii) Possibly, some S is in GC.
- (iii) If some S were in GC, some S would have justified true belief in some p without knowing p.
- (iv) It is possible that some S has justified true belief in some p without knowing p.

Thus: not (i)

Having outlined a preliminary idea of thought experiments, I shall address what might be their most puzzling feature. In 'normal' experiments, we settle a question about independent reality by observation. Experiments are more sophisticated versions of observational practice. One arranges for standard observational conditions which are ideal for answering a question, and then one observes what happens under these conditions. For instance, in order to test whether there are Higgs bosons, physicists built a large hadron collider in which particles were accelerated until they had almost light speed. Under these conditions, Higgs bosons could be observed.

In thought experiments, one main ingredient of normal experiments is lacking. We do not observe an independent reality. One may try to frame thought experiments as observations of one's own reactions to certain considerations, but in my view this would be misleading. Thought experiments simply do not aim at observation in the way normal experiments do. The question becomes how merely imagined scenarios can be informative. Relatedly, when does it make sense to answer a question by using such a scenario?

Although there is a huge literature on thought experiments, these questions have not yet found a wholly satisfactory answer. Instead of trying to present one of my own, I shall consider an answer dating back to the first half of the 20th century. I find this answer interesting not only because it has been somewhat neglected in the literature but also because of the peculiar dialectical situation. While the point of thought experiments is difficult to appreciate in principle, the difficulty is much aggravated in a strongly empiricist framework. The answer I shall consider is bound to such a framework.

2. *Schlick's 'Sinnkriterium' for Thought Experiments*

Moritz Schlick is famous for being the founder of one of the most influential groups of philosophers to have flourished in the 20th century, the Vienna Circle. Schlick was also one of the main authors to set the circle's agenda. Among his tenets ranks the famous 'Sinnprinzip': the meaning of a statement consists in the conditions of its empirical verification. He also endorsed his own version of logical positivism, the view that any meaningful question has to be settled either by analysing one's use of language or by empirical means. Given these key convictions, it comes barely as a surprise that Schlick seems highly critical of thought experiments as far as they draw on merely invented scenarios:

...the philosopher is barely interested in merely fancied, invented objects; it is the real world that poses the big problems for him. ([1929] GAI/6: 162; all translations are mine)

The context of this passage from Schlick's 1929 article *Erkenntnistheorie und moderne Physik* (*Erkenntnistheorie and modern physics*) is the following: Schlick contends that the task of epistemology is complete if it can account for scientific knowledge of reality. There is no need for it to consider objects which are not actual. Now this seems precisely what thought experiments like Gettier's do: they make us consider invented situations which are not actual. Thus, Schlick seems to say that philosophers should not bother about thought experiments.

However, there are also remarks which point in the opposite direction, in particular the one originally in French from which I took the title of this article:

The representation of worlds departing from the real one requires a serious effort of imagination... But is fancy a privilege of poets? Don't we have a right to suppose it in philosophers? ([1935] GA I/6: 607)

Here Schlick seems to say that philosophers can be expected to use their imagination just as poets to represent worlds which are different from the real one. The context of this passage, the thought experiment to be considered in section 3.2. below, makes clear that Schlick does not oppose but endorses certain efforts of philosophers to come up with fictive scenarios which diverge from reality. The question becomes how to reconcile these two remarks.

There is one obvious way of reconciling the two quotes. The reconciliatory proposal is that philosophers may consider non-actual scenarios as long as considering them contributes to answering questions about reality, the ones philosophers are interested in. However, this requirement leads to new concerns: given Schlick's empiricist creed, we access reality by experience. We make observations and theorize about them. This is how we answer questions about reality. How could fictive scenarios contribute to such an access?

In order to solve this problem, I shall take inspiration from a key verificationist tenet of Schlick. Thought experiments should contribute to answering questions about reality. Schlick imposes a verificationist constraint on meaningful questions:

A question is in principle answerable (I should like to say: it is a „good question“) if we can imagine the experiences which we would have to have in order to give the answer ([1932] GA I/6: 404)

A question has to be answerable, perhaps not here and now, but in principle. Otherwise it would miss its point as a question. A sufficient (and presumably necessary) condition for a question to be answerable is that we can anticipate the experiences which would allow to answer it in imagination.

In assigning the role of anticipating experience to imagination, Schlick seems to subscribe to a simulationalist view of imagination.

Here is a classical statement of this view:

Imaginative projection involves the capacity to have, and in good measure to control the having of, states that are not perceptions or beliefs or decisions or experiences of movements of one's body but which are in various ways like those states—like them in ways that enable the states possessed through imagination to mimic and, relative to certain purposes to substitute for perceptions, beliefs, decisions, and experiences of movements. (Currie and Ravenscroft 2002: 11)

In this quote, Currie and Ravenscroft present the imagination as a capacity of recreating or simulating mental states, among them perceptual states as we enjoy them in experience. Schlick assigns a key role to such a recreative imagination. The ability of using imagination is a prerequisite of our ability to ask and answer questions and thus of any intellectual activity. In order to grasp a question, we must be able to use imagination in anticipating the possible experiences which would serve to answer the question.

The notion of imagination needs to be clarified, though. Many philosophers bind imagination to a capacity to conjure up qualitative states like visual imagery as contrasted to states with purely non-qualitative content like propositions, concepts, and the like (cf. Kind 2001). Schlick seems to agree. This leads him to a qualification of his condition for meaningful questions:

I do not think, for instance, that we can be charged with talking nonsense if we speak of a universe of ten dimensions, or of beings possessing sense organs and having perceptions entirely different from ours; and yet it does not seem right to say that we are able to imagine such beings and such perceptions, or a ten-dimensional world. But we *must* be able to say under what *observable* circumstances we should assert the existence of the beings or sense-organs just referred to. ([1936] GA I/6: 730)

In this quote, Schlick seems to acknowledge that we can ask meaningful questions about a universe of ten dimensions or beings with completely different sensory experiences than ours. Such topics go far beyond our reality. Our reality might eventually turn out to be one with ten dimensions or beings with completely different sensory experiences, but we cannot simply presuppose that it will. Judging from Schlick's criterion for good questions, we should be able to imagine experiences which would make us answer the question whether such scenarios are real in the affirmative. However, we cannot imagine ten dimensions or what it would be like to have completely different sense perceptions, says Schlick. The reason, I surmise, is that imagination is bound to qualitative states we are in a position to recreate. We cannot qualitatively represent ten dimensions or sense experiences which are completely different from ours.

One may wonder why Schlick emphasizes these limits of imagination. One answer is that he considers the claim that we would have to imagine a universe with ten dimensions or beings with different sense

organs in order to imaginatively anticipate the experiences we would have to make to posit the existence of such items. This claim seems doubtful. After all, we might posit these objects by broadly abductive reasoning, i.e. as theoretical entities which explain experiences with quite a different qualitative content. Anything else would amount to an implausibly radical empiricism, according to which theoretical concepts somehow have to be built from qualitative experiences. Although there are some indications that Schlick at a certain point in his career flirted with such a radically empiricist view of conceptual content (Oberdan 1996: Sec. 2), I shall not further discuss this aspect of Schlick's work. Suffice it to say that, judging from the above quote, Schlick does not hold that we would have to imagine objects like a ten-dimensional universe or alien perceptions directly.

In order to make room for meaningful questions about a universe with ten dimensions etc., we do not have to imagine a universe with ten dimensions or what creatures with alien sense organs experience directly but only which experiences of ours would lead to positing such items by way of theorizing on our experiences, for instance by inference to the best explanation. For instance, the best explanation of our actual observations of the physical realm may be to posit ten dimensions, even if we can only perceive three of them. And the best way of accounting for the function of dog whistles may be to claim that dogs can hear sounds in the ultrasonic range, even if we cannot imagine hearing such sounds. Taking into account such indirect ways of imagining the pertinent experiences, we can uphold a definition of meaningful questions in terms of imagination.

In how far do these findings on meaningful questions bear on discerning useful thought experiments? I venture a constructive proposal: a thought experiment is useful precisely if it contributes to answering a meaningful question about reality. For a question to be meaningful, we have to imagine the experiences which would allow us to answer it. I suggest that there is an analogous condition for thought experiments:

Sinnkriterium: a thought experiment is meaningful only if we can imagine the experiences which would confirm to us that the experimental scenario is real.

This is a constructive proposal. In order for us to use a thought experiment, it must contribute to answering a meaningful question about reality. A question is meaningful precisely if we can imagine the experiences that would lead to answering it. It does not follow that we have to consider the experiences which would confirm that the thought experimental scenario is real. Alternatively, one may think of a more indirect relationship between experience and the scenario, in particular that experience only confirms the scenario to be *possible* in some sense. This alternative seems even more plausible, or at least better in tune with our current ways of thinking about thought experiments.

However, Schlick's practice of thought experimenting supports that he indeed had something like my constructive proposal in mind. One may feel uncertain about my broad use of 'meaningful'. Shouldn't the notion be restricted to linguistic meaning? I suggest that we think of thought experimental descriptions which have a linguistic meaning and thus can be assessed as to whether they are meaningful.

I shall now present three thought experiments discussed by Schlick in which I see the *sinnkriterium* at work. In order to perform a good thought experiment, we have to imagine the experiences which would confirm that the experimental scenario is real. Moreover, this imagination should bear on answering the question about reality which the thought experimenter set out to answer.

3. *Three Exemplary Applications*

3.1. *Poincaré's Thought Experiment*

My first example is a thought experiment which Schlick adapts from the physicist Henri Poincaré. The question to be answered is whether physical magnitudes are absolute or only relative to other magnitudes, in particular whether there is absolute space as Newton had it. To answer this question, Poincaré invites us to imagine all spatial structures to suddenly grow by the same proportion:

Imagine that all bodies in the world over night grow to huge size, their dimension is enlarged by the factor 100... I am a Goliath of 180m and use a 15m fountain pen to draw letters on the paper which are several meters high, and in an analogous fashion all other magnitudes in the universe have changed, such that the new world, though enlarged, geometrically resembles the old one. ([1917] GA I/2: 198–199)

Schlick devotes a lengthy discussion to the precise general formulation of this thought experiment. As it stands, it does not answer Poincaré's question. It leaves open key issues like whether the masses of objects also change. Schlick eventually settles for a formulation in terms of a suitable mapping of spacetime points which is in tune with his philosophy of physics. These subtleties do not matter for my general topic. I shall consider the case as originally described under the simplifying assumption of a static universe which only undergoes the sudden transformation described by Poincaré. Moreover, all our measuring devices are assumed to be geometrical ones.

According to the *sinnkriterium*, in order to deal with this thought experiment, we have to imagine the experience which would confirm the scenario to be real, Schlick notes:

What would I feel like after such a change? I wouldn't notice the change. Since all objects have participated in the enlargement, all objects and instruments, we would lack any means to figure out the imagined change. ([1917] GA I/2: 199)

There can be no experience which would confirm that we are in Poincaré's scenario, says Schlick, adding:

This whole change exists only for those who mistakenly argue as if space were absolute... Hence the enlarged universe is not only indistinguishable from the original one, it simply is the same universe, there is no sense in talking of a difference as the absolute size of a body is nothing 'real'. ([1917] GA I/2: 199)

Schlick's remarks show that we need to be careful in applying the *sinnkriterium*. Originally, one would have thought that a meaningful thought experiment requires to imagine the experiences which confirm that the scenario is real. In contrast, Poincaré's thought experiment seems to work precisely by our inability of imagining such experiences. How could that be?

Here is my proposal how to construe the dialectics of Poincaré's thought experiment. Poincaré describes a scenario which his opponent who believes in absolute space is committed to accept as a meaningful thought experiment: all spatial magnitudes might change proportionally although we would be unable to detect that they do. It is not Poincaré but his opponent who must be prepared to perform this thought experiment. Applying the *sinnkriterium*, we notice that the scenario is not meaningful. For we cannot imagine the experiences which would confirm that the scenario is real. This shows that the idea of absolute space leads to absurd consequences: one must accept a scenario as meaningful which does not make sense. Poincaré's opponent would have to answer which experiences would confirm that the scenario is real, but there is no positive answer to this question.

I note that there is also a weaker interpretation of the dialectics. Sometimes it seems as if Schlick had only in mind that unobservable change is nothing that makes sense to a *physicist*, who underlies stronger obligations of supporting her claims by observation. I grant that Schlick at this point may not yet invoke a general *sinnkriterium*. But if we consider how to embed his take on Poincaré's experiment into his overall philosophical position, the more ambitious interpretation seems plausible.

3.2. *Private Psychological States*

My second example can be dubbed the thought experiment of private psychological states. Schlick envisions a scenario in which mental states are completely isolated from physical ones. The initial question which motivates this thought experiment is the following: can statements on mental states be reduced to statements about physical states? The question is motivated. Many pundits nowadays say things like 'the brain feels, thinks...'. If we reason this claim through, we may end with the claim that my state of, say, being in pain, is identical or reduces to a certain physical state of my brain. A related claim is that a sentence like 'some being is in pain' is a sentence about a certain identifiable physical state. Against this claim, Schlick develops his thought experiment. He imagines a scenario in which there are beings with quali-

tative mental states. They experience what it is like to be in such a state. But there is no correlation between these qualitative states and anything physical. To Schlick, true sentences about the qualitative states of these beings are not sentences about anything physical. This shows that statements about mental states do not in principle reduce to statements about physical facts.

My interest is not so much the success or failure of this thought experiment, but how the experiment is presented by Schlick. In Schlick's description of the experiment, we can see the *sinnkriterium* at work. Schlick says about his scenario:

We should perhaps talk of two realms, one physical, public, common, the other private, psychological, consisting entirely of monologues... the two worlds would be parallel *but they remain connected*. ([1935] GA I/6: 607, m.e.)

The final sentence is puzzling. Why do the two worlds, the physical and the psychological one, have to be connected? In what way are they connected? And how does this connection square with Schlick's stipulation that there is no correlation between private mental and physical states?

In my view, the answer again lies in the *sinnkriterium*. In order to perform the experiment, we have to ask which experiences would confirm that there are the two separate realms, the physical and the psychological one. Experience would have to confirm to *one and the same* cognizer both that there is the physical realm and the isolated psychological realm. This can only be done if the cognizer herself has access both to the physical and the psychological realm. The cognizer must on the one hand have suitable experiences of the physical world. These experiences must be systematically correlated with physical facts. On the other hand, she must also have a range of experiences which so completely lack any systematic correlation with physical states that she cannot even communicate them to others.

To illustrate the point, assume that there is a community of researchers who lack eyesight. However, only one of them, Mary, additionally has intense psychedelic colour experiences which occur randomly. Since the others do not have colour experiences and there are no physical correlates to Mary's experiences, there is no way she could communicate to the others what she is experiencing. At best the others could notice (if they take her avowals seriously) that she has a random pattern of experiences which they have no further access to.

One may question the experiment by doubting that one can have a private language to be used for monologues about private experiences. More importantly, one may ask what modal status we have to assign to the scenario for it to say something about psychological sentences in our language. Perhaps all true psychological statements in our language are perfectly correlated with physical statements. As a consequence, one may wonder why the theoretical alternative of psychological state-

ments which are not correlated in this way with physical statements matters if our main interest is to settle questions about reality. But it is not my purpose here to assess the success or failure of the thought experiment. My interest is only to show how Schlick's metatheory of thought experiments drives his interpretation of his own experiment. The combination of access to the physical and the private realm in one and the same cognizer is a direct result of the *sinnkriterium*.

3.3. *Immortality*

My third example is interesting especially due to its aftermath in the history of 20th century philosophy. It illustrates Schlick's empiricist take on the age-old question of human immortality. To appreciate the standing of the question: when we nowadays read Descartes's *Meditations*, we are primarily interested in his *Cogito ergo sum*, his radical doubt, his mind-body dualism. But Descartes himself titled the *Meditations* 'Meditations on the first philosophy, in which the existence of God and the immortality of the soul are demonstrated' (Descartes 1641). The question of immortality seems to have been a primary preoccupation of Descartes. Moreover, he approached the question by purely intellectual inquiry, detached from all sense experience.

As an empiricist, Schlick must take a completely different approach. He addresses the question by asking what experience might contribute to answering it. To Schlick, the main contribution would concern empirical evidence that one has survived one's own bodily death. Here is what this evidence might be like:

In fact I can easily imagine, e.g., witnessing the funeral of my own body and continuing to exist without a body, for nothing is easier than to describe a world which differs from our ordinary world only in the complete absence of all data which I would call parts of my own body. ([1936] GA I/6: 731–733)

Again Schlick develops a thought experimental scenario, one's survival of one's own death, by asking which experiences might confirm that this scenario is real. He envisions the experience of attending his own funeral without having any experiences confirming that he has a body. It is an interesting question how Schlick could imagine watching his funeral without thereby having data about his having an embodied perceptual system standing in physical contact with his physical surroundings. It also sounds strange to talk of parts of the body as data. A realist may insist that parts of the body are not simply bits of information, they are material beings out there. But again, my purpose is not to discuss the minutes of Schlick's experiment. Instead I note that, to Schlick, the scenario of surviving one's own death makes sense only if we can imagine the experiences which would confirm that the scenario is real.

Schlick's empirical twist of the issue of immortality has sparked criticism by Bernard Williams. Williams says:

Schlick famously claimed that survival after death must be a contingent matter, because he could imagine watching his own funeral. In

order to make good this claim, Schlick would have had to give a coherent account of how, as participant at his own funeral, he could be himself, Schlick; all the problems of continuity, personal identity, and so forth are called up. (Williams 1973: 40)¹

Williams notes that Schlick took survival of one's own death to be a contingent matter, as contrasted, for instance, to Descartes, who considered it a consequence of the necessary metaphysical structure of the world, not to be ascertained by observation but by purely intellectual inquiry.² I do not think that Schlick aimed at establishing the contingency of survival after death, though. Rather he wanted to bring out the only way to make sense of the very question of immortality: by telling how we could find out whether we are immortal by empirical means.

Williams's second criticism is more interesting: Schlick might have devised a scenario of a subject watching Schlick's funeral, but what could confirm to the subject that it is the same person, Schlick, who is being buried and watching his funeral? I think that this criticism, whatever its ultimate plausibility, is telling. It shows the limitations imposed on thought experiments by Schlick's *sinnkriterium*. Either the question whether it is he himself, Schlick, who observes his funeral, is a meaningful question. Then the question must be principally answerable by experience, for instance by the experienced continuity of psychological states. Or the question does not make sense because it cannot be answered empirically. In this case, Williams criticism might still apply. It might just show that Schlick's thought experiment did not live up to his own standards. He would not have devised conditions that could empirically confirm his surviving his own bodily death. And this failure might indicate that the whole question of immortality becomes meaningless by Schlick's standards.

4. *In Conclusion*

I have illustrated Schlick's *sinnkriterium* for thought experiment by several applications. But what are we to make of this account? Is it just a curious footnote in the history of logical positivism? I shall close with two remarks.

On the one hand, Schlick's criterium surely imposes strong limitations on thought experiments. Nowadays these precise limitations do not seem overwhelmingly plausible. For instance, we presumably can conceive a universe which exists although there is no way of ascertaining its existence by observation, for instance our universe as it would have been if there had been no intelligent life. This thought experiment tells us something about our reality, as witnessed by the

¹ Thanks to Bernhard Thöle for bringing this passage from Williams to my attention.

² More precisely, Descartes thought that the soul is necessarily immortal as far as its continuous existence only depends on God's continuous support and not on anything physical.

discussion of the so-called anthropic principle among scientists. The argument from the anthropic principle roughly goes as follows: there is nothing remarkable about the universe giving rise to conscious life. If it were different, we would simply be unable to observe it. The opposite impression is just due to selection bias. The thought experiment makes sense. But if we apply Schlick's *sinnkriterium*, we would have to ask which observations could confirm the existence of a universe devoid of intelligent life, and, of course, there can be no such observations.

Moreover, there are doubts that Schlick's *sinnkriterium* elucidates our standard way of tackling thought experiments. For instance, surely we can answer which experiences would confirm us that a Gettier case is real. As for GC, we have to observe a person looking at a clock, observation must confirm us that the clock stopped precisely 24h earlier, and so on. But this answer is trite. It does not really capture anything that matters in dealing with this thought experiment. In particular, Schlick offers nothing like the sophisticated apparatus of alethic modalities which structures the current debate of thought experiments. This leaves us somewhat clueless about how merely imagining experience which might be arbitrarily unlikely to become real could tell us anything about our reality. The problem already surfaced at the end of section (3.2.). Schlick does not offer an answer to the crucial question how mere imagination can generate *new* information as Mach did in his proposal that tacit empirical constraints are written into our minds by evolution.

On the other hand, in recent times, empiricist tendencies in modal epistemology are on the rise (e.g. Bueno and Shalkowski 2015, Martínez 2015, Fischer and Leon 2017). Philosophers have become suspicious of lofty possibility claims which are not somehow grounded by empirical science. The same goes for thought experiments. Notwithstanding huge differences in detail, empirically-minded philosophers may be inspired by Schlick's thoroughly empiricist attitude, which also becomes manifest in his account of thought experiments.

References

- Bueno, O., Shalkowski, S. A. 2015. "Modalism and Theoretical Virtues: Toward an Epistemology of Modality." *Philosophical Studies* 172 (3): 671–89.
- Currie G. and Ravenscroft, I. 2002. *Recreative Minds*. Oxford: Oxford University Press.
- Descartes, R. 1641. *Meditationes de prima philosophia*. Paris: Michel Soly.
- Fischer, B. and Leon, F. (ed.). 2017. *Modal Epistemology After Rationalism*. Cham: Springer.
- Kind, A. 2001. "Putting the Image Back in Imagination." *Philosophy and Phenomenological Research* 62: 85–110.
- Mach, E. 1897. "Über Gedankenexperimente." *Zeitschrift für den Physikalischen und Chemischen Unterricht* 1: 1–5.

- Martínez, M. 2015. "Modalizing Mechanisms." *The Journal of Philosophy* 112: 658–670.
- Miscevic, N. 1992. "Mental Models and Thought Experiments." *International Studies in the Philosophy of Science* 6: 215–226.
- Oberdan, T. 1996. "Postscript to Protocols: Reflections on Empiricism." In A. Anderson and R. Giere (eds.). *Origins of Logical Empiricism*. Minnesota Studies in the Philosophy of Science: Vol. XVI. Minneapolis: University of Minnesota Press: 269–291.
- Ørsted, H.C. 1822. "Oersted über das Studium der allgemeinen Naturlehre." *Journal für Chemie und Physik* 36: 482.
- Schlick, M. [1917]. *Raum und Zeit in der gegenwärtigen Physik*. GA I/2: 159–287 [Moritz-Schlick-Gesamtausgabe I/2. Wien-New York: Springer].
- _____. [1935] *De la relation entre les notions psychologiques et les notions physiques*. GA I/6: 583–609.
- _____. [1929] *Erkenntnistheorie und moderne Physik*. GA I/6: 161–172.
- _____. [1932] *A New Philosophy of Experience*. GA I/6: 397–414.
- _____. [1936] *Meaning and Verification*. GA I/6: 709–749.
- Williamson, T. 2009. "Replies to Ichikawa, Martin and Weinberg." *Philosophical Studies* 145: 465–476.